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ON THE IMMUNITY OF THE KANSAS BOTTOM GROUND WATERS TO CHANGES IN THE COMPOSITION OF THE KANSAS RIVER WATER.

By PROF. C. C. YOUNG.

THE extended period of dry weather during the three years previous to the series of analyses following led to a shortage of ground water in the bottoms where the Lawrence Water Company obtains the supply furnished the city. It was deemed advisable to have some check on the water company, so that we would be able to tell when Kaw river water was used to reinforce the insufficient ground-water supply.

From time to time during the years 1909, 1910 and 1911 sufficient analyses of the Kaw and the Lawrence city supply had been made so that it was certain that the ground water was very nearly constant in composition, while the river varied over wide limits.

Collection of samples for comparative analyses from the Kaw and city supply was commenced on January 9, 1912. The chlorine content of the city supply at that time was 60 parts per million, which is about normal for that time of year. The river showed 168 parts per million. On January 10 the tap water contained 88 parts per million and the river 142. A trip to the pump house revealed the fact that the water company had the suction line to the river wide open and were pumping river water. The use of varying amounts of river water continued until February 9, when its use was discontinued until the period from November 22 to December 16.

The breaks in the chlorine content for the city water are very marked, and show readily the admixture of river water with the ground supply. A simple calculation will give almost the exact amount of river water that had been added at any one time.

The statement is often made by the layman, and, I am sorry to say, by some engineers, that the water pumped from the Kaw bottoms is nothing more than river water that filters back through the sand into the wells, but a study of the curve will show that the composition of the ground water is affected only slightly by season changes, and not at all by the composition of the Kaw. For instance, the time between February 15 and June 1 is the highest period of chlorine in the ground water and the lowest in the river.

The lowest values for chlorine in the city supply are during high time of chlorine in the river. It will be seen that the low values for chlorine in the river is during the period of greatest precipitation, and the opposite is true of the city supply. If the river had the slightest effect on the ground-water composition it would unquestionably show up on this supply, for, as may be seen by a

PLATE I.

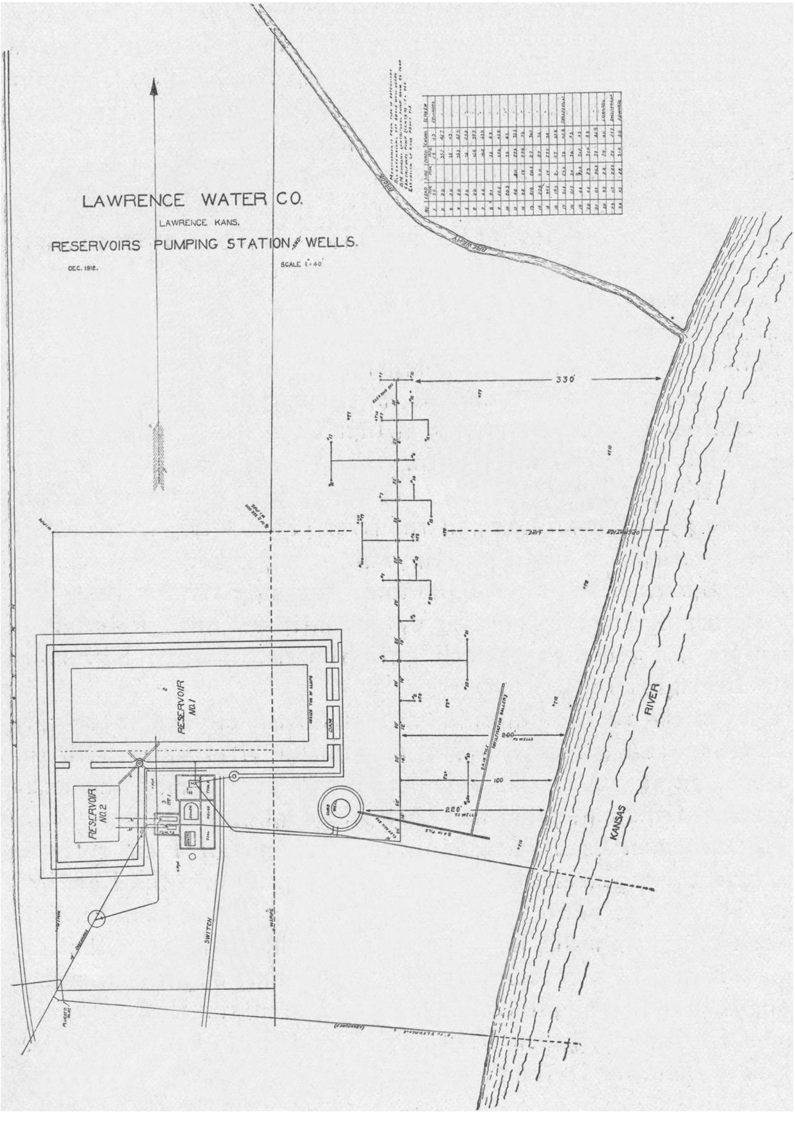
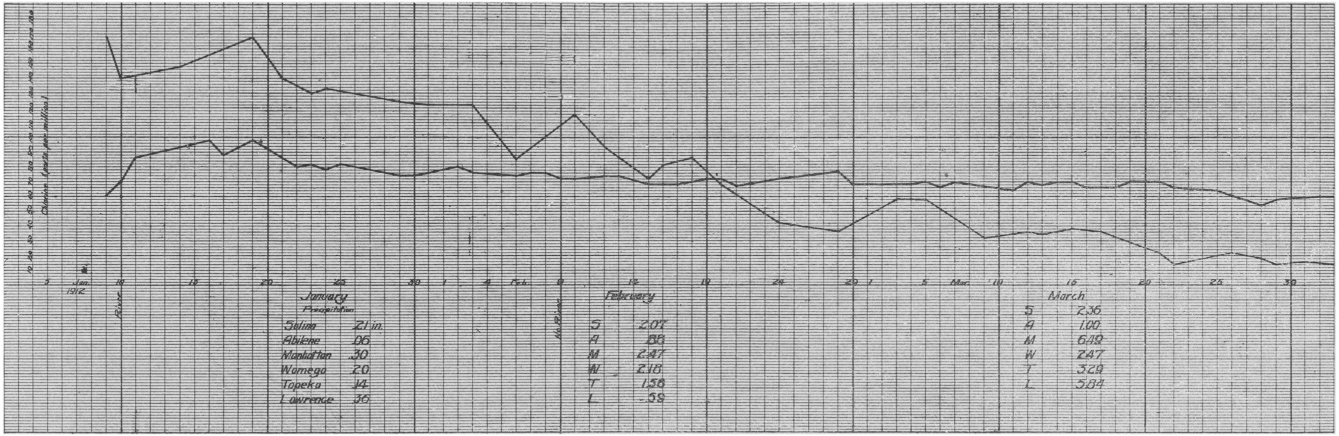
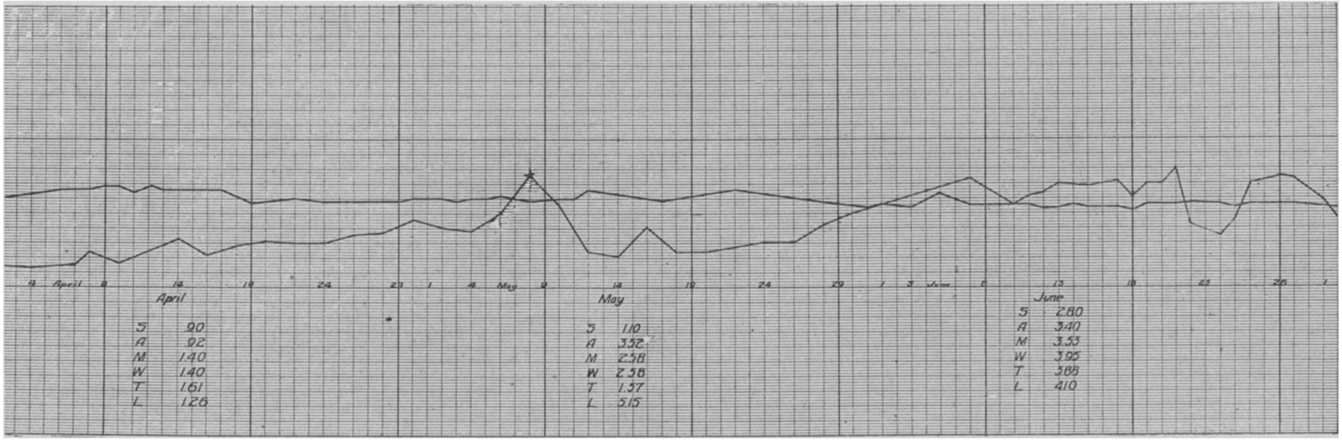


PLATE II.



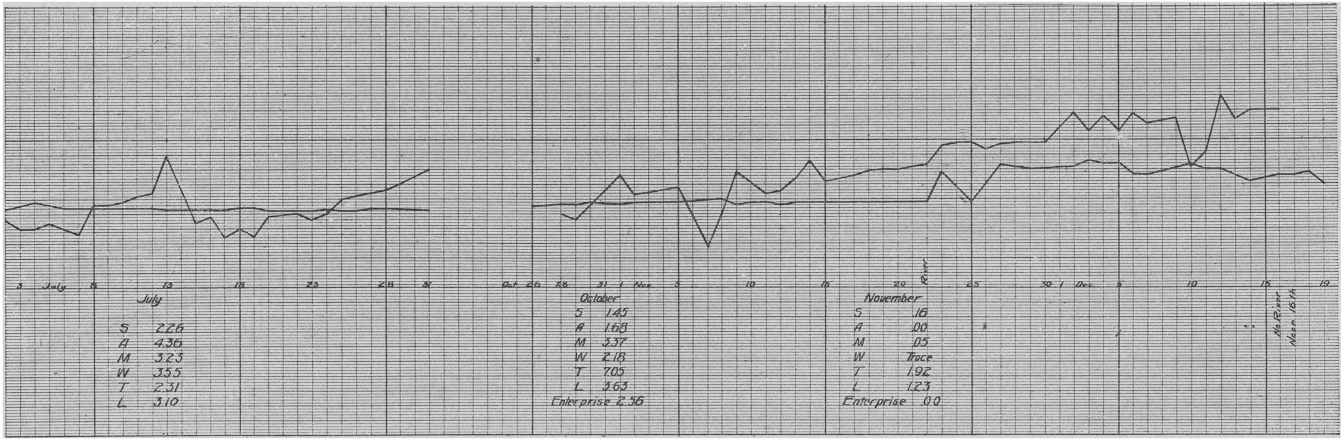
Comparison of chlorine content of Kaw river and ground water.

PLATE III.



Comparison of Chlorine content of Kaw river and ground water—*Continued.*

PLATE IV.



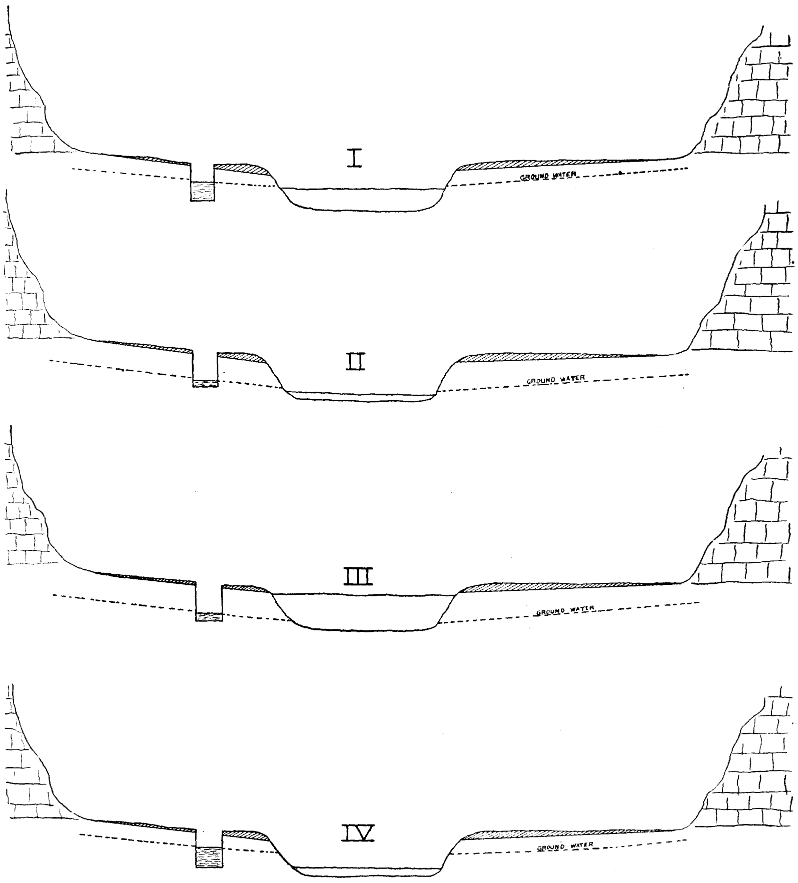
Comparison of chlorine content of Kaw river and ground water—*Concluded.*

glance at the map, a very large portion of the supply is obtained within 150 feet of the river banks. The plan of the Lawrence Water Company's collection system is shown herewith.

The one effect that the river has on the ground water is to cause it to raise or lower according to the height of the river. The river does not filter back through the sand to raise the water in the wells, however, but its effect is explained by the geologist in a similar way to that portrayed in the accompanying sketches.

No. 1 shows the normal condition of the river when it is flowing with the bed well filled and the ground water at sufficient height and working under just enough head to pass into the river against the back pressure of the water in the stream. That this condition exists ordinarily is illustrated by the fact that the flow over the dam at Lawrence is one-fourth greater than the combined flow of

PLATE V.



the Kaw at Manhattan and all streams tributary to the Kaw between Lawrence and Manhattan. This reinforcement could have come only from the ground water.

No. 2 shows the condition during a dry time, when if it were not for the stored ground water reinforcing the Kaw it would go dry in a few days.

No. 3 shows the condition that exists when there is a sudden rise in the river sufficient to make the water level much higher in the stream than in the wells. It is this condition that gives the appearance of the river flowing back through the sand into the ground, for the water commences at once to rise in the wells. From the opinion of many eminent geologists, and from a study of the chlorine curve of the river during March, 1912, when this condition existed, I can but conclude that the river does not flow back to the wells, but the raise in the bed is sufficient to create enough head so that the ground water can not enter the river, so must back up in the water-bearing sand and gravel, exactly like any large stream will back up a smaller when the rise comes quickly in the large stream.

No. 4 represents the condition that existed after the floods of 1903, 1904 and 1908, when the river receded rapidly after an extended period of high water, and the ground-water level had risen with the heavy rains and been held in the ground by the flooded streams. At the times mentioned water could be obtained easily by removing the surface soil and scooping out a few inches of sand or gravel.

A few days after the river went down the ground-water level commenced to lower, and continued to do so slowly until the condition shown by the first sketch was again established.

These facts, stated as briefly as possible, seem to prove to the writer, at least, that the Kaw can not affect the ground water in the bottoms.